Norwegian Meteorological Institute

Emissions for CLRTAP modelling - experience and feedback

Ágnes Nyíri on behalf of MSC-W

25.04.2008 Workshop - Verification of emission estimates, Sofia, Bulgaria

Overview

- The effect of the new gridded emissions in 0.1°x0.1° long-lat resolution on model results
- GNFR versus SNAP - temporal and height distribution of emissions
- International shipping emissions - availability and challenges
- How can CAMS81 contribute to EMEP work and vice versa
- Experiences from the NMR+Russia project

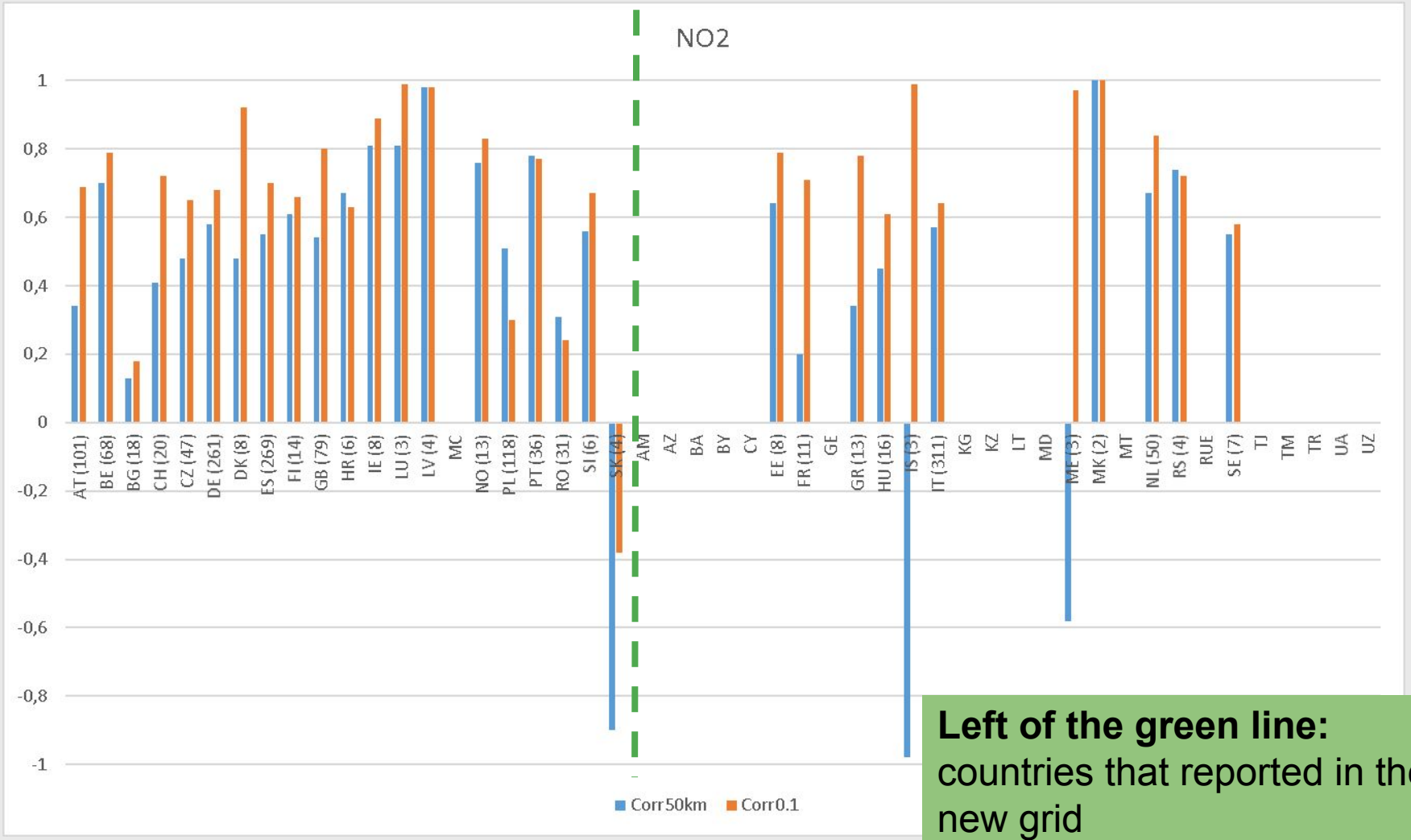
EMEP 0.1°x0.1° emissions and model results for 2015 – comparison to observations

- 22 countries reported sectoral gridded sectoral emissions in the new grid (0.1°x0.1° long-lat resolution)
- Remaining areas: gap filled and spatially distributed by CEIP
- Model runs performed using both 0.1°x0.1° and 50km x 50km emissions for 2015
- Comparison to EMEP (background) and Airbase measurements (rural, suburban, urban, excluding traffic stations)
- Why Airbase data?

  - Because we do not expect to see that much change in the background (that is how the EMEP network was designed).

  - We need a lot of data to look at the spatial distribution (EMEP not enough).

NO_2 – spatial correlation (mod-Airbase) within each country



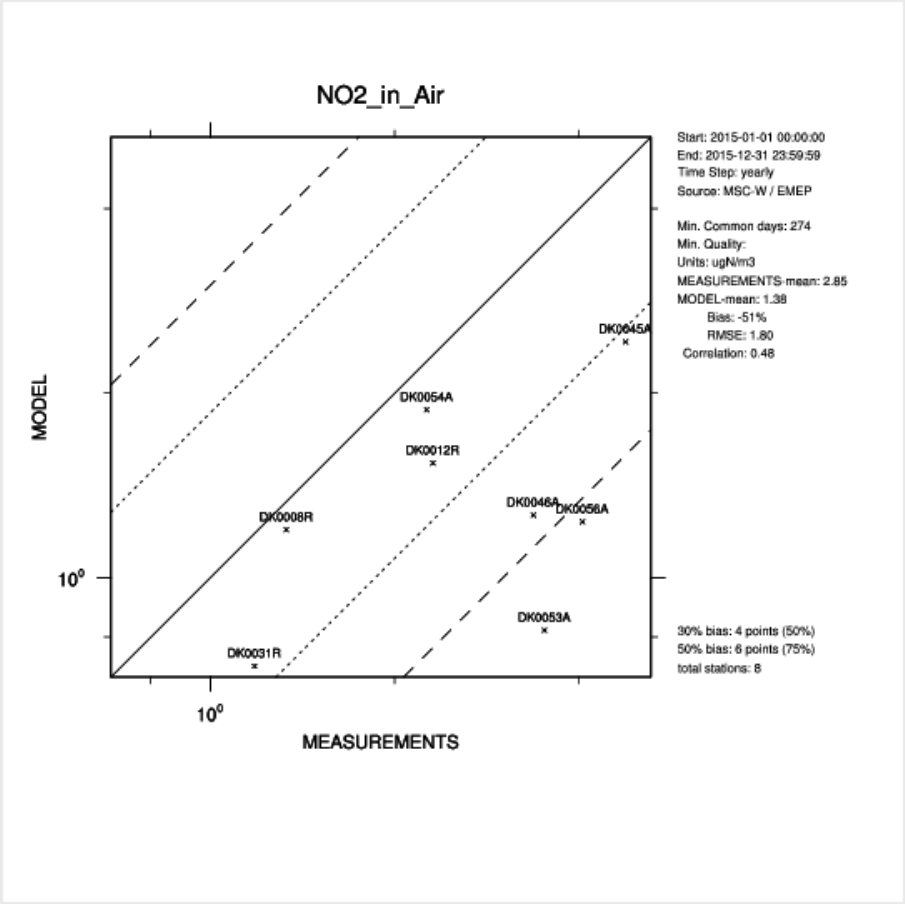
Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

Improved spatial correlation for NO_2
Some countries should be revised (e.g. BG, PL, RO)

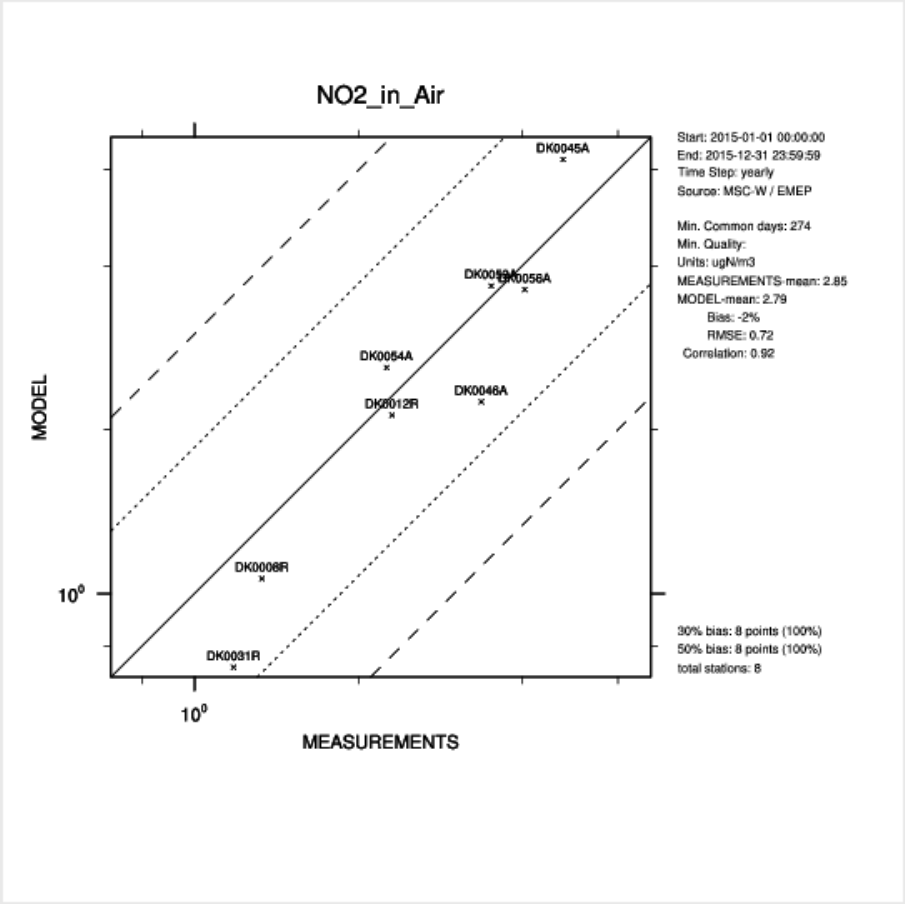
Norwegian Meteorological Institute

Denmark

Significantly improved spatial correlation



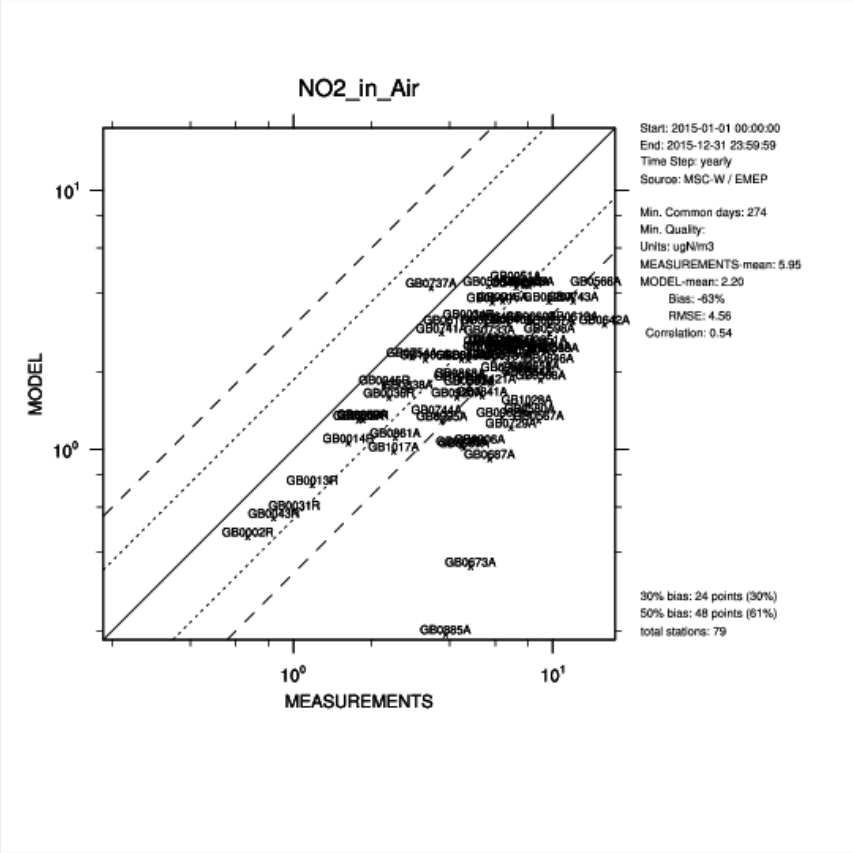
Old emissions
(50kmx50km)

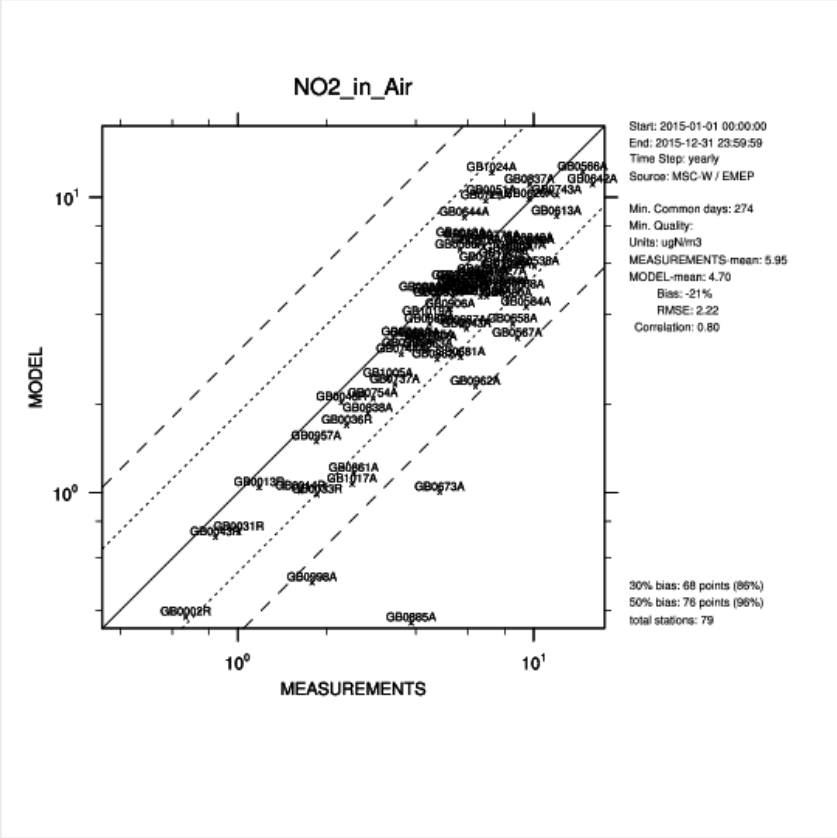


New emissions
(0.1x0.1)

United Kingdom

Significantly improved spatial correlation



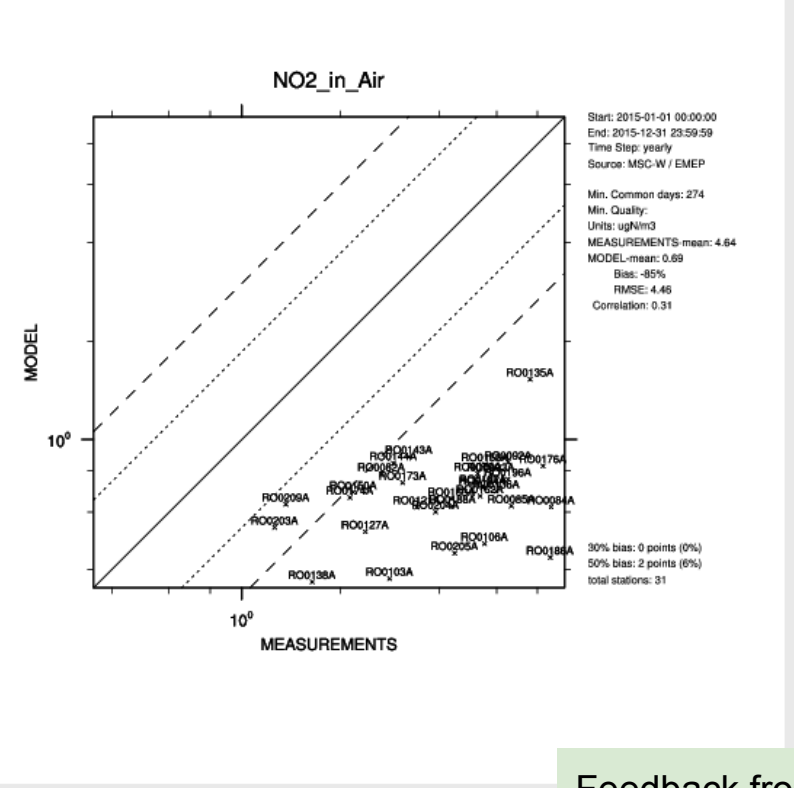


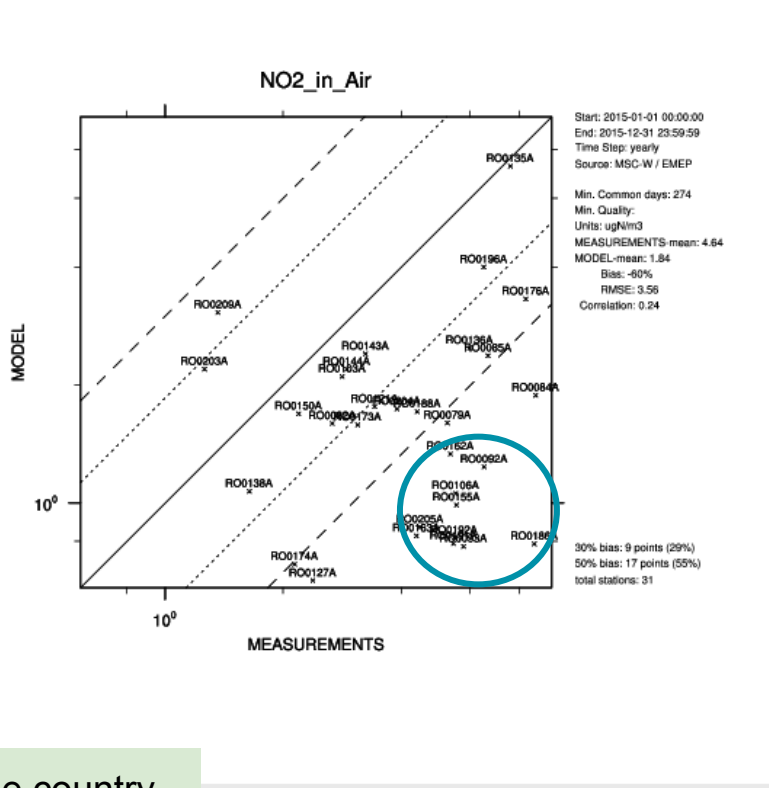
Old emissions
(50kmx50km)

New emissions
(0.1x0.1)

Romania

Worse spatial correlation, but better results for several stations.
(Sources missing in gridding? Or non-representative stations?)





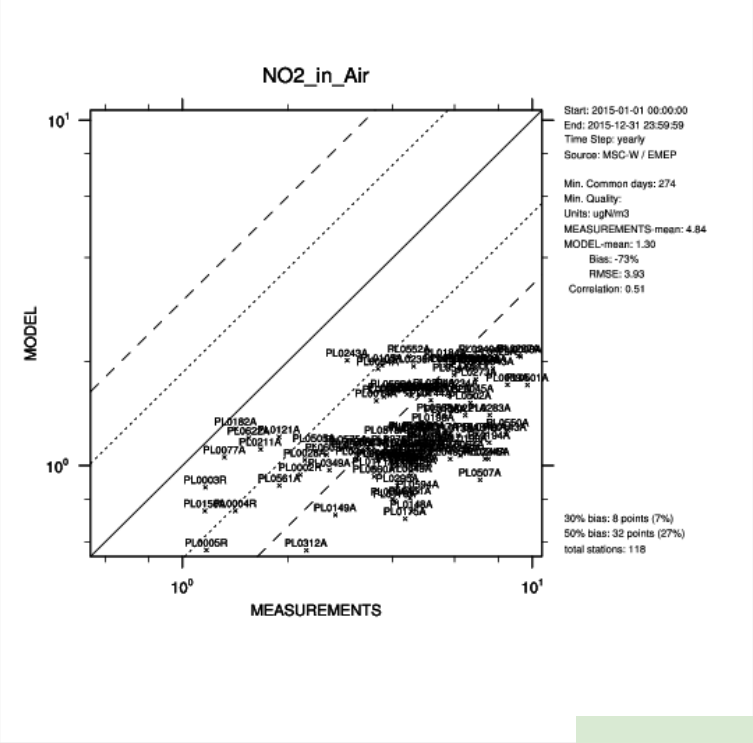
Old emissions
(50kmx50km)

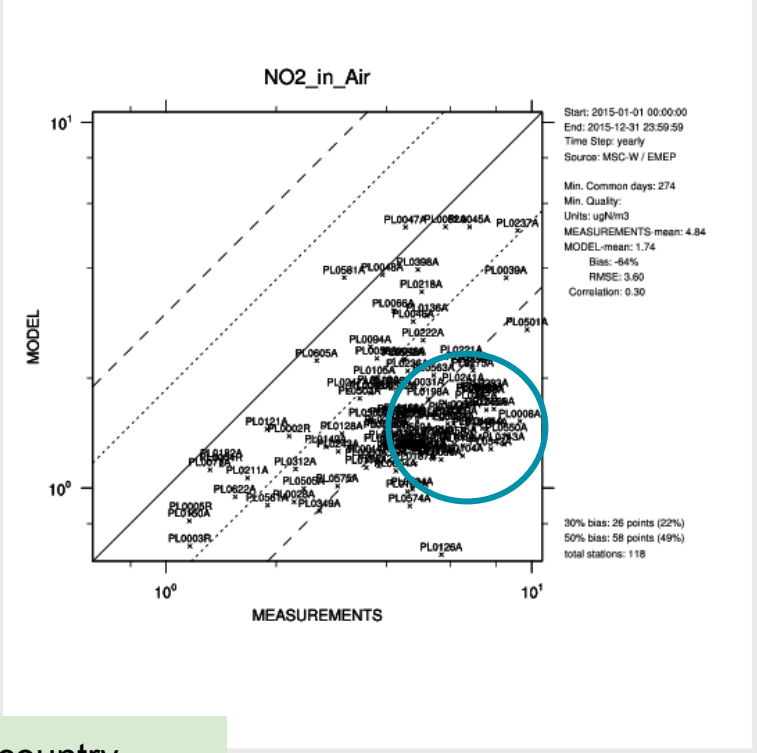
Feedback from the country would be very useful, (emissions, observations, local modelling).

New emissions
(0.1x0.1)

Poland

Worse spatial correlation, but better results for several stations (Sources missing in gridding? Or non-representative stations?)



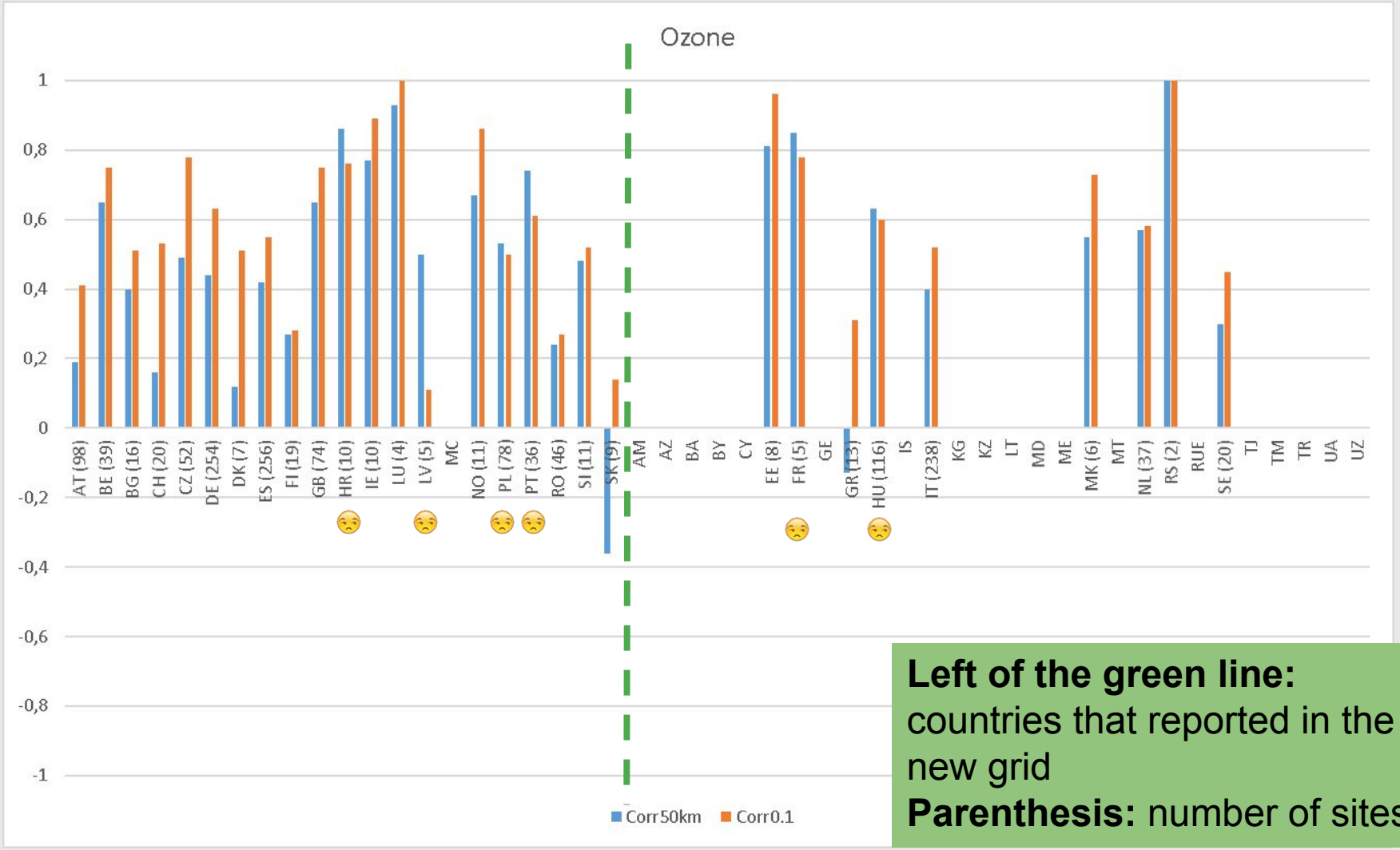


Old emissions (50kmx50km)

Feedback from country would be very useful, emissions, observations, local modelling

New emissions (0.1x0.1)

O_3 mean – spatial correlation (mod-Airbase) within each country

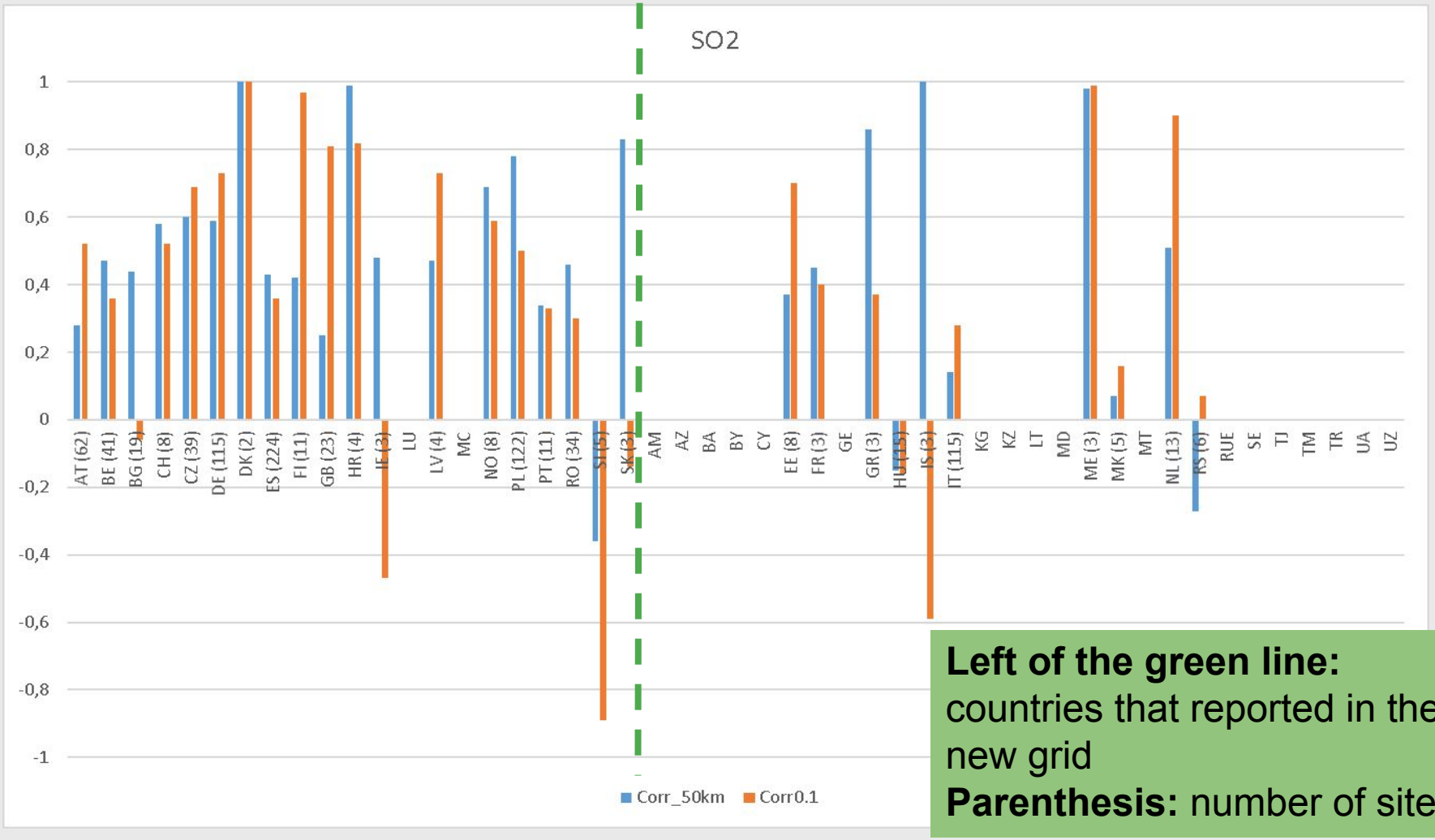


Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

Large improvements in O_3 related to the NO_2 improvements
Improved spatial correlation for O_3 – titration effect
Better reflect long-term exposure and deposition

Norwegian Meteorological Institute

SO_2 – spatial correlation (mod-Airbase) within each country



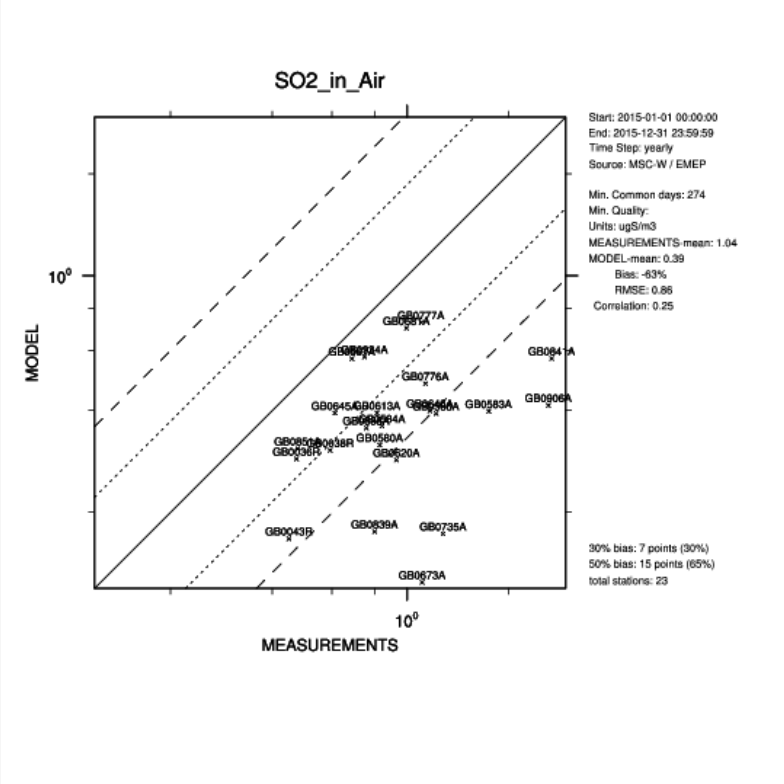
Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

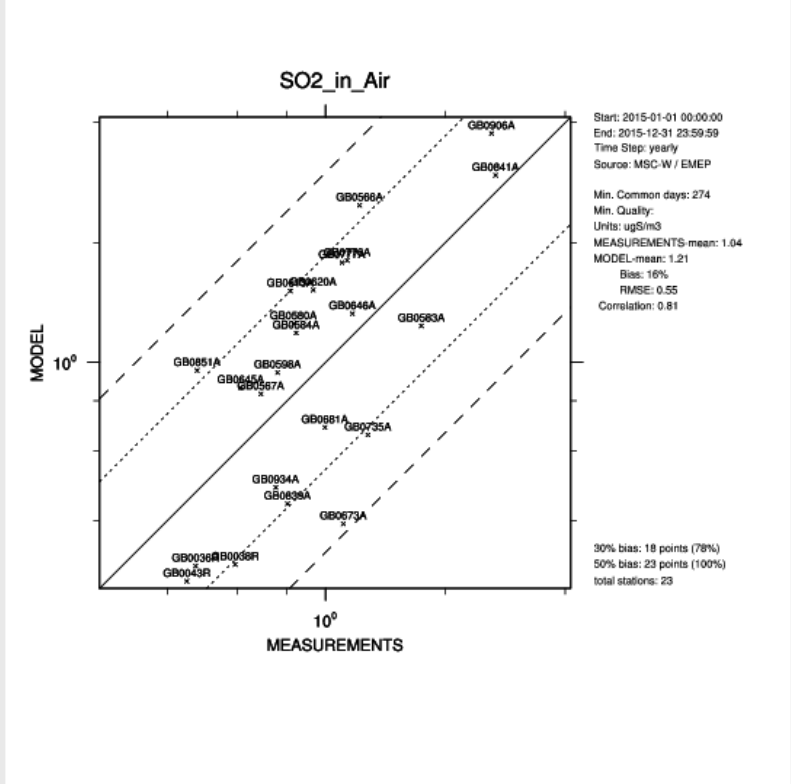
It is more difficult to use surface observations of SO_2 to validate SO_x emissions since a large part of it arises from sources released higher in the atmosphere - mixed results

Norwegian Meteorological Institute

United Kingdom

Significant improvement





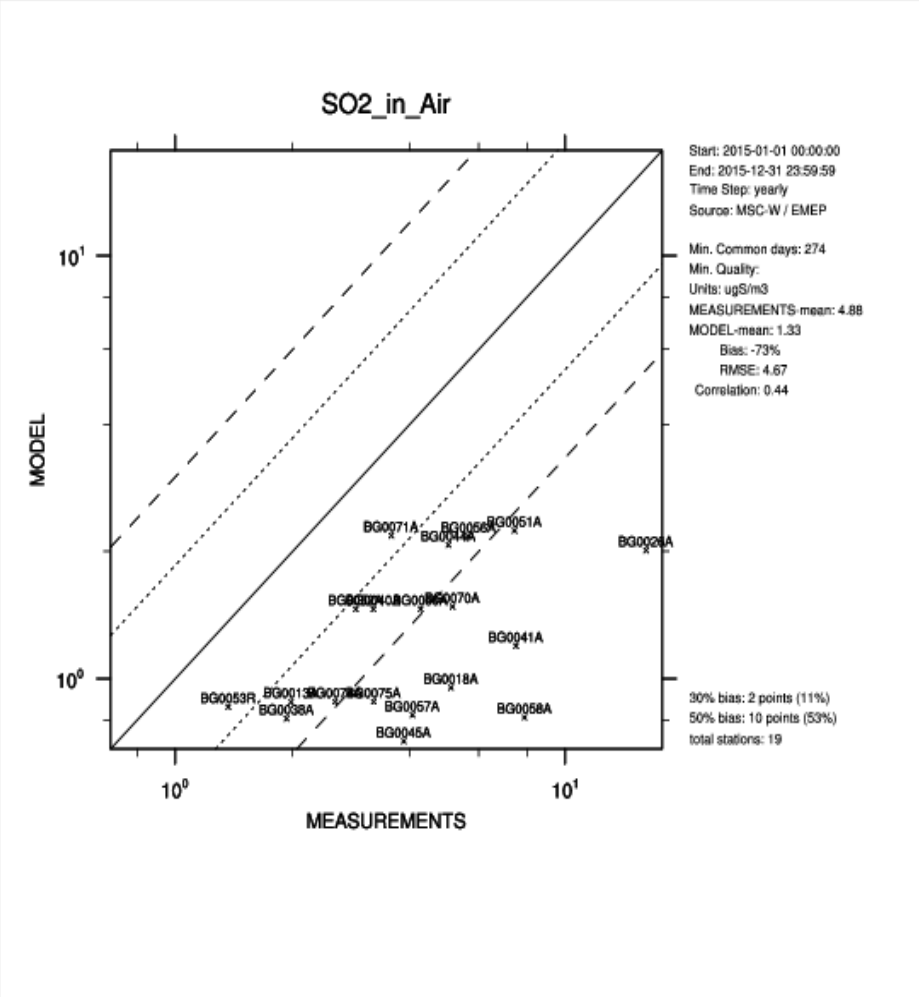
Old emissions
(50kmx50km)

New emissions
(0.1x0.1)

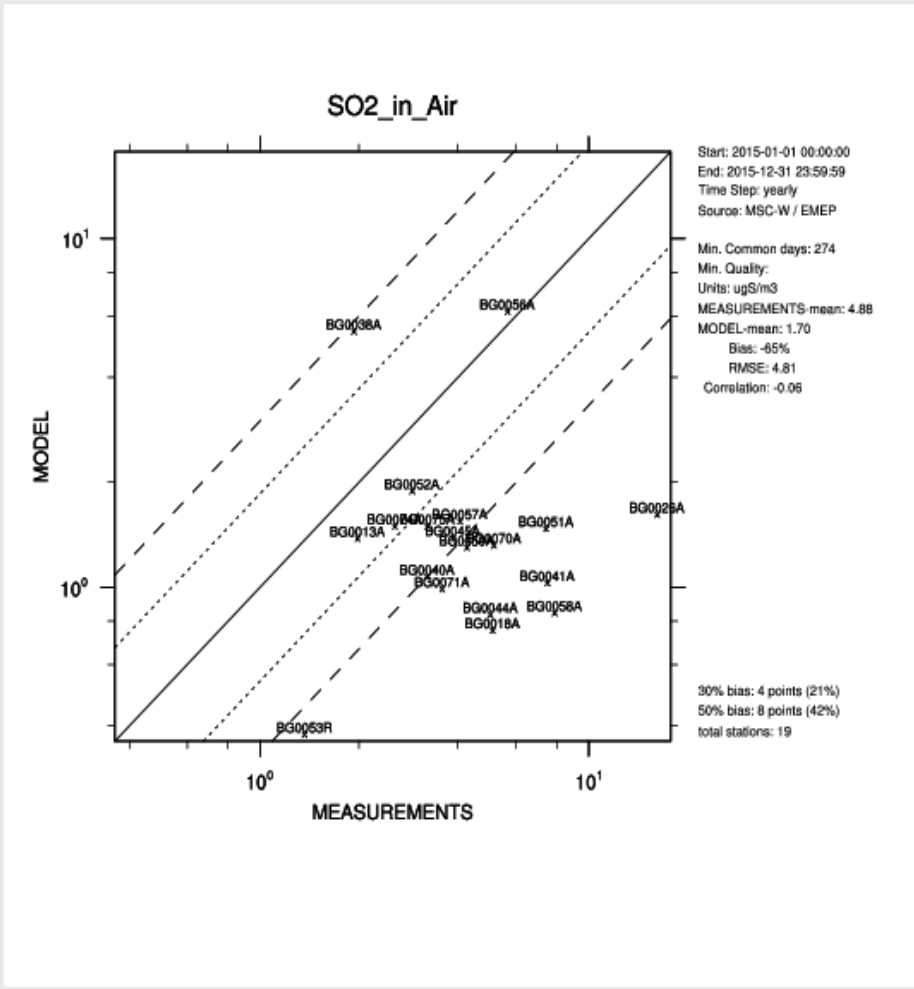
Norwegian Meteorological Institute

Bulgaria

Not much improvement



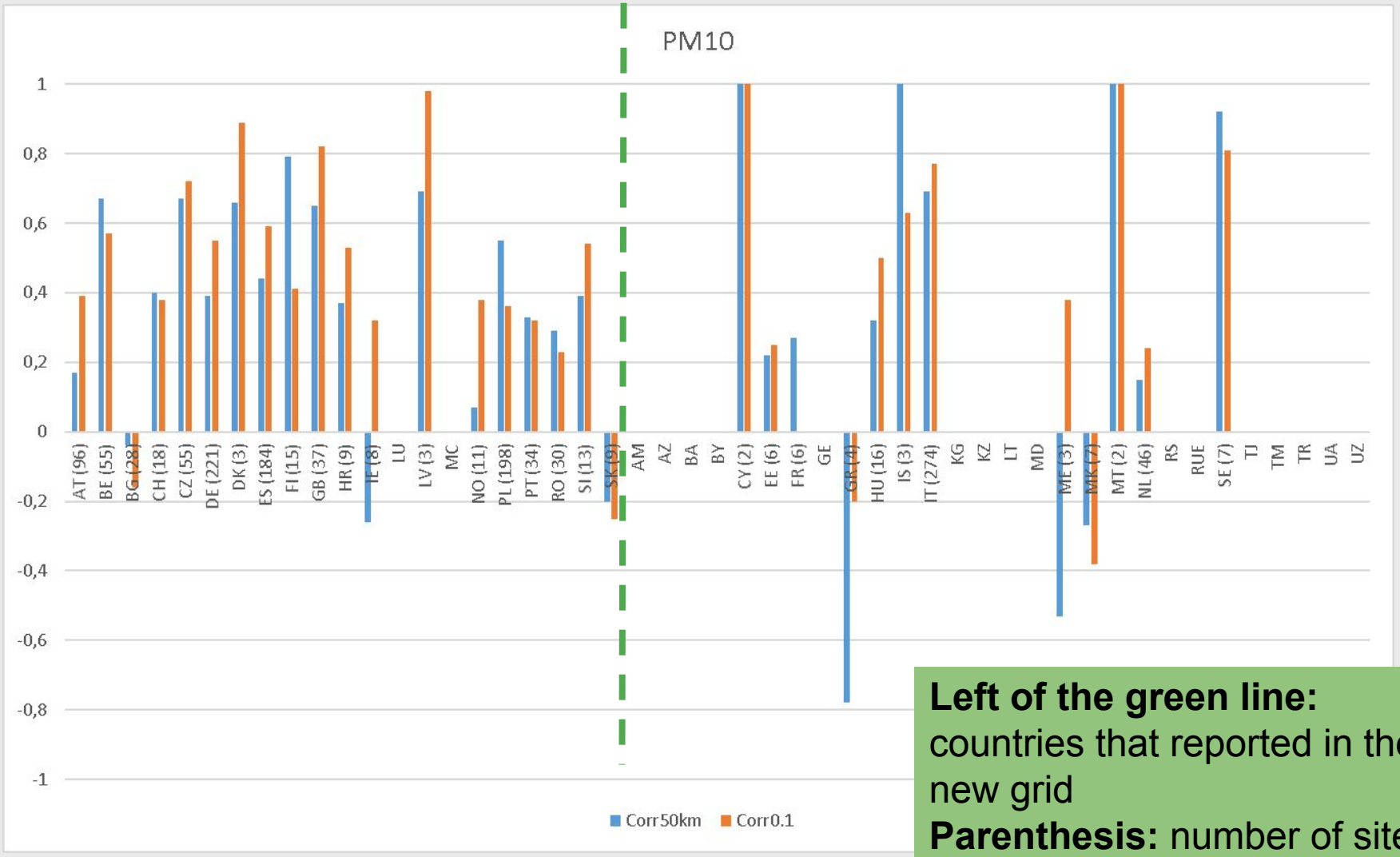
Old emissions
(50kmx50km)



New emissions
(0.1x0.1)

Norwegian Meteorological Institute

PM_{10}– spatial correlation (mod-Airbase) within each country

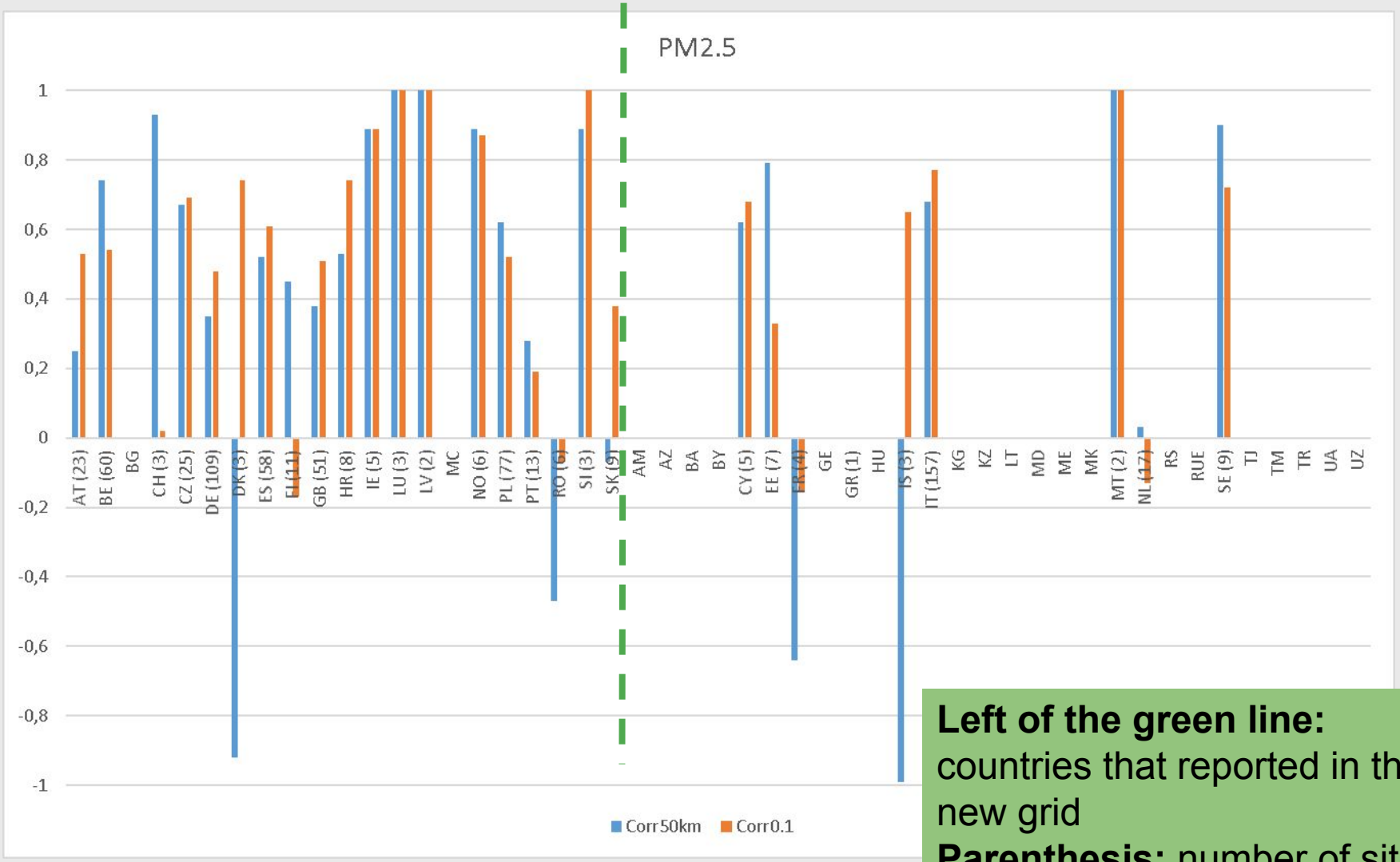


Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

Improved spatial correlation in the majority of countries

Norwegian Meteorological Institute

PM_{25}– spatial correlation (mod-Airbase) within each country



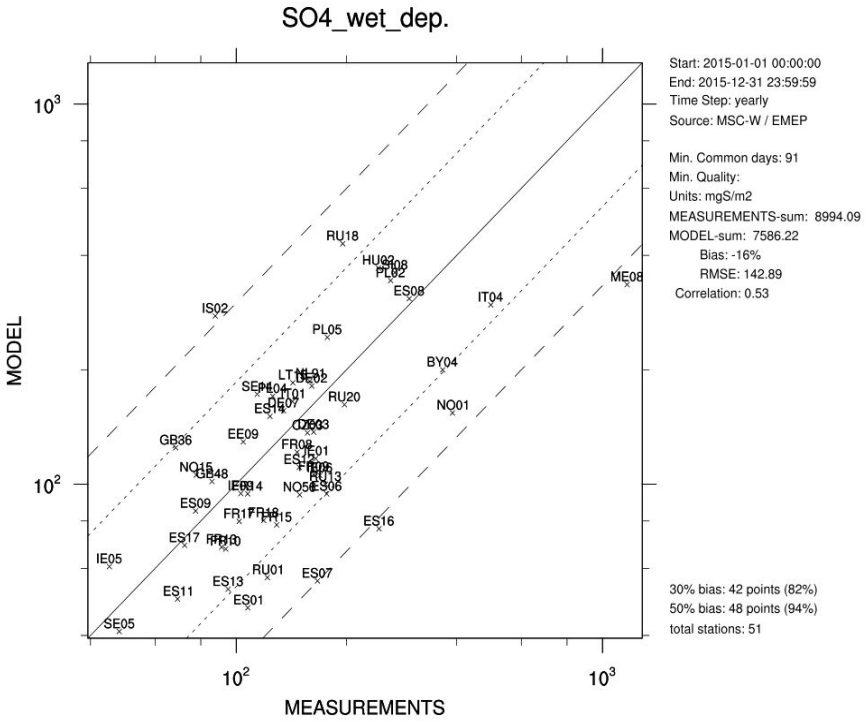
Left of the green line: countries that reported in the new grid
Parenthesis: number of sites

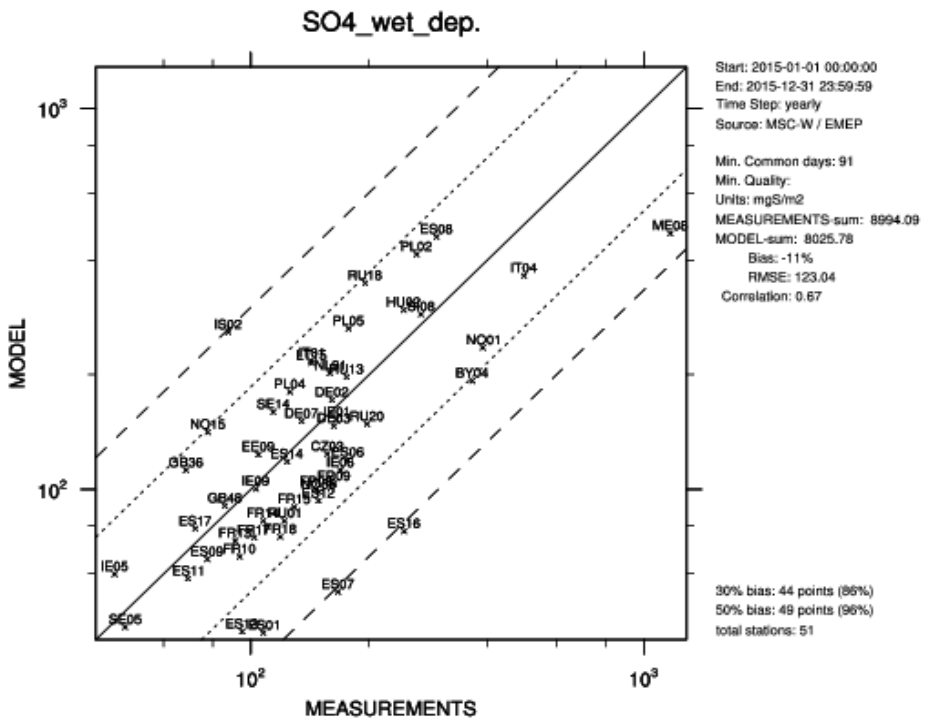
Improved spatial correlation in the majority of countries, but more mixed results (and less measurements)

Norwegian Meteorological Institute

Wet deposition of SO_4

Some improvement, similar for NO_3





Old emissions
(50kmx50km)

New emissions
(0.1x0.1)

Norwegian Meteorological Institute

Summary

- Both the regridding done by the countries and by CEIP provide NO_x emissions that improves the model results for NO_2 (and O_3).
- For SO_2 the results are more mixed, as expected.
- Smaller improvements for PM, as expected.
- Improved observation-model correlation for wet deposition (especially for SO_x and NO_x)
- For countries that have few observations it is difficult to interpret whether the new gridding is better than the old.
- More knowledge about the national observation networks is necessary to judge the performance.
- Some countries might benefit from revising their gridding, others should submit gridded data - feedback is very welcome (both with respect to observations, emissions, local modelling, local scientific expertise).

GNFR versus SNAP

A ‘PublicPower’ (1)
B ‘Industry’ (3)
C ‘OtherStationaryComb’ (2)
D ‘Fugitive’ (4)
E ‘Solvents’ (6)
F ‘RoadTransport’ (7)
G ‘Shipping’ (8)
H ‘Aviation’ (8)
I ‘Offroad’ (8)
J ‘Waste’ (9)
K ‘AgriLivestock’ (10)
L ‘AgriOther’ (10)
M ‘Other’ (5)

SNAP 1 ‘Combustion in energy and transformation industries’
SNAP 2 ‘Non-industrial combustion plants’
SNAP 3 ‘Combustion in manufacturing industry’
SNAP 4 ‘Production processes’
SNAP 5 ‘Extraction & distribution of fossil fuels and geothermal energy’
SNAP 6 ‘Solvent and other product use’
SNAP 7 ‘Road transport’
SNAP 8 ‘Other mobile sources and machinery’
SNAP 9 ‘Waste treatment and disposal’
SNAP 10 ‘Agriculture’
SNAP 11 ‘Other sources and sinks’

Mapping of GNFR sectors to time factor, height distribution and emission split classes (originally defined for SNAP sectors). Better data are needed.

International shipping emissions in the EMEP area

- For trend studies consistent shipping emissions are important
- Discontinuities because of regulatons, linear interpolation between years (or based on economic growth) is not sufficient
- Change from TNO-MACC to FMI shipping emissions (in 2017)
- Future: rely on CAMS? (MET, FMI, TNO, CEIP partners)
- How to estimate shipping emissions in the past?

	Sulphur Gg SO_2			**NOx** Gg NO_2		**CO** Gg CO		**$PM_{2.5}$** Gg, see caption			
	SO_2	SO_4						Ash	EC	OC	
Baltic Sea	10.3	0.8	*-84%*	321	*18%*	22	-21%	1.5	2.0	5.0	*-23%*
North Sea	23.8	1.5	*-84%*	695	*8%*	51	*-24%*	3.4	4.7	11.9	*-26%*
Mediterr. Sea	675	40	*-27%*	1353	*-10%*	94	*-38%*	6.4	8.8	22	*-66%*
Black Sea	68	3.9	*36%*	172	*118%*	13	*63%*	0.9	1.2	3.0	*-15%*

Difference between TNO-MACC ship emissions (2011) used in 2016 and FMI ship emissions (2015) used in 2017.

01.01.2015 SECA for Baltic Sea and North Sea (from 1% to 0.1% sulphur content)

How will CAMS81 contribute to EMEP work and vice versa?

CAMS81: Contract on emissions, under the Copernicus Atmosphere Monitoring Service

Partners: CNRS (coordinator), TNO, FMI, CUNI, MSC-W (MET Norway), CEIP (EAA), Chalmers, BSC, MPIC

- European anthropogenic emissions: based on officially reported data, but enhanced/gap-filled by expert knowledge (TNO) and international shipping emissions (FMI) - in coordination with CEIP
- Ship emissions for 2016 currently under review at TNO (to resolve the issue of double counting: distinction between inland/marine shipping is not the same as domestic/international) (FMI)
- Time factors: detailed profiling for key pollutant source categories will be developed using meteo parameters and sector-specific statistics. The source categories that are envisaged to be selected include residential combustion, agriculture and road traffic (TNO)

How will CAMS81 contribute to EMEP work and vice versa? (cont'd)

- BVOC: calculated with MEGAN model and ERA-interim meteo data for the period 2000-present (CUNI)
- Soil-N (MET Norway)
- Volcanic emissions: SO2 emissions provided by Chalmers University in coordination with the NOVAC network (2005-2016). Ash emissions provided by MET Norway in the case of a major eruptions in Europe
- Natural emissions from oceans: DMS, OCS and halogens, based on what is available in the literature and recalculated using ECMWF meteorological parameters.

Towards improving emission data from Russian Federation (some highlights from the joint NMR+Russia project, IVL coordinator)

According to the national experts (SRI Atmosphera St. Petersburg, Russia), discrepancies have been identified between CEIP and official emissions. Particularly large differences are found for SO_x which are probably due to different location of LPS applied by CEIP.

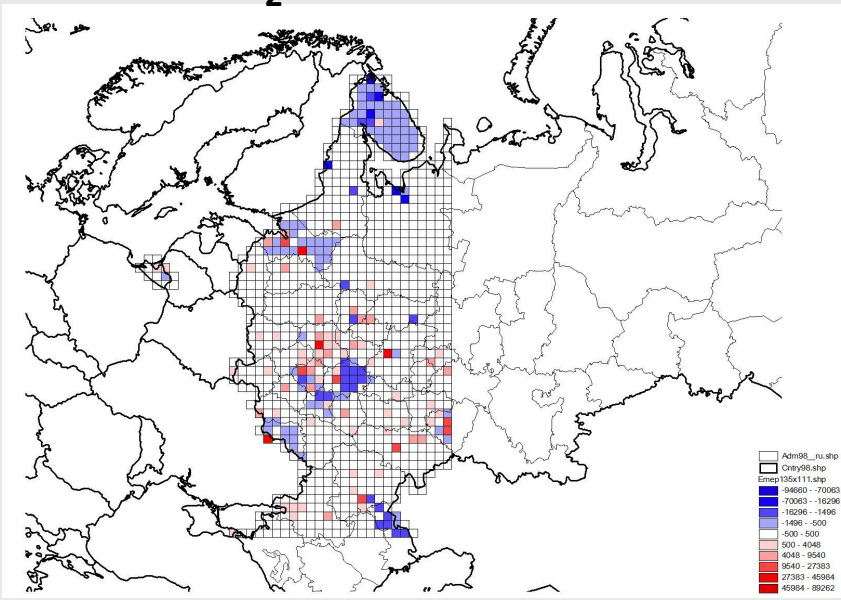
CEIP vs. national data, SO_2 emissions

Russian Federal Districts with major differences in 2010 emissions

diff = CEIP- National

N	Region	Diff, kt
1	Murmansk oblast	-182
2	Komi Republic	-94
3	Orenburg oblast	-87
4	Moscow oblast	69
5	Arkhangelsk oblast	-58

SO_2 in 2012: CEIP - national

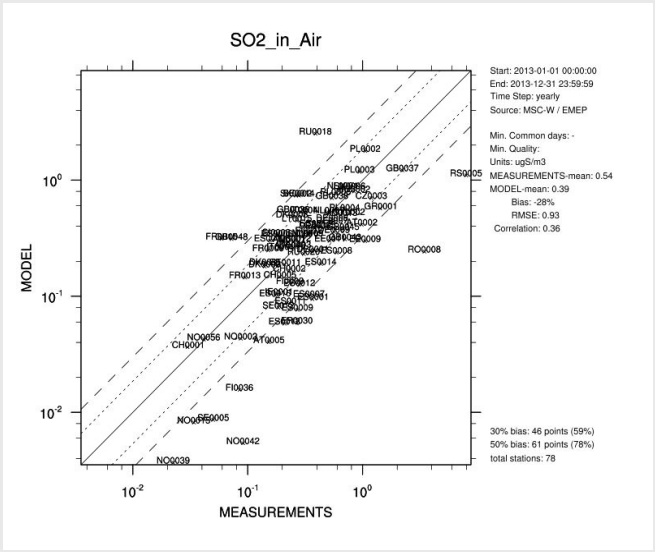


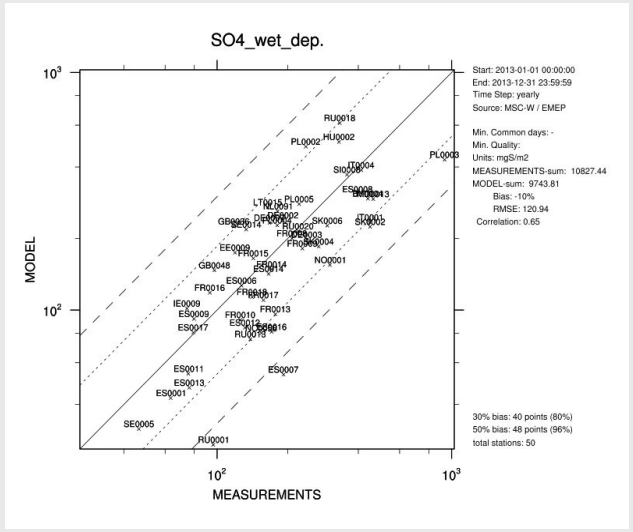
Total difference for European part of Russia: 100 kT (2012 update), 320 kT (2015 update)

Norwegian Meteorological Institute

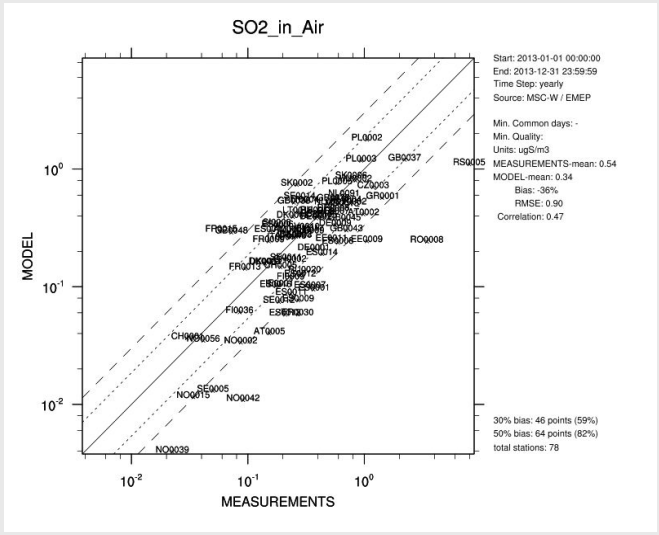
Scatterplots for model (50x50 km) vs observation for 2013

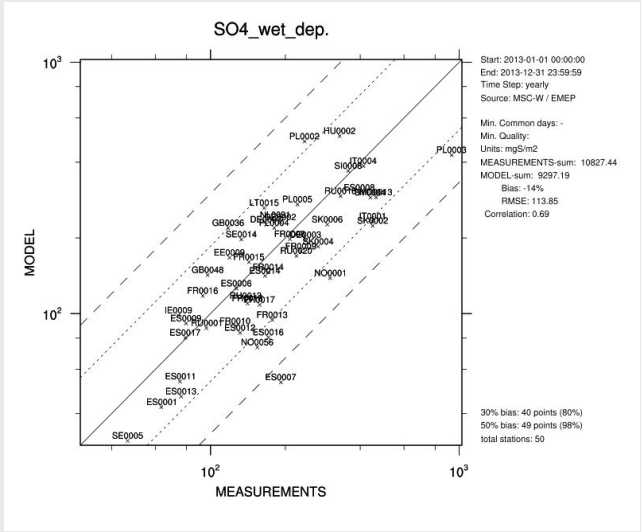
CEIP emis





SRI Atm emissions for RF





Improved model results for Russian (RU0001, RU0018) and some Nordic sites (NO0042, FI0036)

Norwegian Meteorological Institute

Conclusions

- Emissions in the new 0.1°x0.1°long-lat grid improve the model performance.
- Further improvement is expected when more countries report gridded emissions in the new grid and/or revise their gridding.
- More up-to-date temporal distribution of emissions should be developed (CAMS81, national expertise or a dedicated project).
- Shipping emissions are important, it is challenging to estimate emission trends based on the available data.
- Several deliverables for the CAMS81 project can be useful for CLRTAP modelling.
- National emission data should be reported within deadline in order to be included in the modelling.


Norwegian
Meteorological
Institute